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STUDY PLAN

INTERPRETATION OF RANGE CONDITION TREND DATA

by

Jack N. Reppert
Range Scientist

Rocky Mountain Forest and
Range Experiment Station

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Submitted by Jack N. Reppert Date 6/30/67
Jack N. Reppert
Range Scientist

Approved by Richard S. Driscoll Date 6/30/67
Richard S. Driscoll
Project Leader
FS-RM-1707

Reviewed by J. L. Kovner Date 6/30/67
J. L. Kovner
Biometrician
RMF&RES

Concurred in E. H. Reid Date 6/30/67
E. H. Reid
Assistant Director,
Range Management & Wildlife
Habitat Research
RMF&RES

Concurred in R. S. Rummell Date
Robert S. Rummell
Branch Chief,
Range Surveys and Studies
WO

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Problem

The 3-step method[1/] for measuring range condition and trend was developed for administrative use after 3 years of intensive study from 1948 through 1950 (Parker and Harris, 1959). It was adopted as a part of the Forest Service range analysis program in 1956. Improvements and modifications have been added to the method since it was developed.

Currently, most of the 11,670 grazing allotments administered by the Forest Service have one or more 3-step transect clusters located on them. These clusters serve as permanent benchmarks where periodic remeasurement of certain plant and soil characteristics provide data used to infer change or trend in condition, either favorable or unfavorable, according to a prescribed standard. Repeat photographs provide additional evidence of change.

1/ The three steps of the method are: (1) vegetation and soil stability measurements from permanent transects, (2) field summarization of data and classification of current range condition and trend, and (3) two oblique ground photographs for permanent visual record (Parker, 1951).

The field steps of the method are generally understood and usually executed reasonably well. Currently, about one-third of the approximately 20,000 established clusters in the six Western Regions have been remeasured at least once. However, a lack of clearcut methods for properly interpreting and evaluating the data has prevented correct and logical answers to fundamental questions: Has real change in range condition occurred? and, if so, what caused it? This research must, therefore, be oriented to determine <u>how 3-step data can be effectively used in the interpretation of range condition trend</u>.

Range condition trend should be considered relative to the complete management task. Before a range manager can take wise action, based on condition trend data, he must know (1) if the change is statistically significant, (2) if it is "real" or biologically significant, (3) what caused the change and, in some cases, what did not cause the change, and (4) what management action is suggested--action which will often cause additional change.

Knowledge of change, its nature and causes, is basic to this whole interpretation problem. Hence, this study will be directed toward the study of plant community dynamics assumed to be detected by the 3-step procedure. Managers having difficulty in explaining condition trends are likely hampered by a lack of available knowledge about plant community change itself. In many cases change is caused by a combination of many agents.

However, the causative agent which draws the most attention and is often under the most managerial control is livestock grazing. Sometimes it is wrongly assumed that grazing caused the change when some other factor(s) is the real causative agent. In addition, not enough is known about natural variations in range plant communities caused by climatic changes and other factors to avoid faulty conclusions.

The end product of this research will be directions for interpreting 3-step condition trend data. Initially, the purpose of this work will be to find out what the magnitude is of statistically and biologically significant change due to known cause(s) as inferred by existing 3-step data. Secondly, we intend to describe how responsive the method is to known important changes. Other avenues of investigation may stem from this initial work if required to produce a usable set of guidelines for interpretation.

In this problem, the method and sampling scheme have been set and are currently in use, so any interpretations made from these data must be made in spite of procedural shortcomings that may exist. However, it is important to remember that difficulties may be encountered in explaining change using any method unless:

(1) The method measures factors which are sensitive to changes in range condition, and

(2) The sampling scheme is sufficiently unbiased, accurate, and precise so as to detect measurable change.

Past and Current Work

Tests of the method, its usefulness and its shortcomings have been described and discussed by several workers (Hutchings and Holmgren, 1959; Parker and Harris, 1959; Johnston, 1957; Sharp, 1954; Strickler, 1961). The value to this study of the literature is that it tells precisely what characteristics (e.g., loop frequency by 3/4-inch loop) are being measured by the procedure, and what degree of permanence and repeatability can be expected in the sample relocation.

Parts of the 3-step procedure may be modified or even omitted but loop-frequency is the most consistently observed feature of the method and the one that has attracted the most attention and research. The record of presence or absence of plants or soil factors within a 3/4-inch diameter loop has been referred to as cover, cover index, and density index, but is more correctly called loop-frequency (Hutchings, 1959) or frequency (Hyder, 1963).

Greig-Smith (1964) described frequency as being dependent in part on density and in part on pattern. Hyder et al. (1966) point out the usefulness of frequency for classification of sites but stresses the need to determine appropriate quadrat

sizes so that frequency will be between 5 and 95 percent for a maximum number of species. Hyder (1965), from his work in the shortgrass plains, determined that a 2-inch-square quadrat was good for blue grama frequency and a 16-inch-square quadrat good for most less-abundant species. The implication is that the 3/4-inch loop is too small for frequency determinations for many species of the vegetation types where it is now being used. Review of representative 3-step data (Table 1) indicates that only the most common species from the more productive sites have much of a chance to show frequencies above 5 percent. Combining species, as in the desirable group (Table 1) will often give somewhat higher frequencies but they may still be well below 5 percent.

There is concern that loop-frequency may be difficult to relate to changes (trends) in range condition. However, it is just as easy to become concerned about other single attributes adequately describing range condition. For example, as loop-frequency of a species changes, in time, to higher values it means that either the density (number per unit area) or the pattern of dispersion, or both, have increased in a way that results in higher values. Biologically it means live rooted members of the species--nuclei potentially capable of yielding herbage, reproducing themselves, and covering the soil--have become more widespread or more regularly distributed on the

Table 1. Loop-frequency values of the most frequent grass species and the desirable plant group from representative clusters.

Species	3/4" Loop-Frequency First Reading	Last Reading	Allotment and Cluster	Forest	Region
Festuca scabrella	3.8	9.5	Flagstaff	Lewis	1
Festuca idahoensis	19.2	20.8	C-1 (outside	and	
Desirable species	26.0	34.0	exclosure)	Clark	
Festuca ovina	8.8	8.5	Cold Sprs.	Gunnison	2
Danthonia parryi	8.0	4.5	C-3 (outside		
Desirable species	23.8	22.5	exclosure)		
Bouteloua gracilis	1.0	1.3	Old Camp	Prescott	3
Muhlenbergia torreyi	0.3	0.7	C-2		
Desirable species	0.0	0.0			
Bouteloua gracilis	17.7	44.7	Fort Bayard	Gila	3
Aristida spp.	0.0	0.7	C-5		
Desirable species	0.0	0.3			
Bromus inermis	6.7	5.0	Adams Gulch	Sawtooth	4
Agropyron cristatum	1.7	1.7	C-1		
Desirable species	8.4	6.7			
Poa spp.	8.0	6.7	Harvey Valley	Lassen	5
Sitanion hystrix	3.0	4.3	C-1		
Desirable species	8.0	6.7			
Agropyron spicatum	0.7	3.3	Flagtail	Malheur	6
Elymus spp.	1.0	1.7	C-143		
Desirable species	2.3	6.0			

area. It does not necessarily mean that the species showing increased frequency is actually producing more herbage or more ground cover.

It is incorrect to assume that a change in frequency will automatically be matched by a corresponding change in plant cover. To do so can easily lead into an interpretive trap. There is evidence that some range examiners are currently making this mistake. Actually a positive bias exists which means that loop-frequency will ordinarily be larger than cover values--basal or crown. If the 3/4-inch loop is thought of as a very large pin, comments by Goodall (1952) apply and explain bias due to pin size. Goodall stated, "assuming that the vegetation is still and the pin moves vertically through it, the area within a single open space in which the center of the pin must fall if the pin is not to touch the foliage is less than the total area of the open space by the amount depending on the diameter (or radius) of the pin." Positive bias is further recognized by both Parker (1950) and Hutchings (1959) who report that the 3/4-inch loop overrates plant cover.

Examples drawn from research done since that reported by Parker and Harris (1959) illustrate the variability and magnitude of loop-frequency relative bias (Table 2) when compared to cover values. These data show that while the relative bias is large for smaller sized plants, it often approaches 1.0 (no bias) for larger plants such as shrub crowns.

Table 2. Variability and magnitude of bias for 3/4-inch loop-frequency compared to cover values.

Literature Reference	Location	Species	Average Plant Size	Estimated Method	Cover Value (percent)	Loop Frequency (percent)	Bias (freq. ÷ cover)
Hutchings, 1959	Desert Exp. Range, Utah	*Eurotia lanata*	24.8 sq.in.	Measured	11.0	12.3	1.12
		" "	2.2 sq.in.	Crown	3.4	5.3	1.56
"	Upper Snake R. Exp. Range, Idaho	*Agropyron spicatum*	1.99 sq.cm.	Measured	0.83	5.95	7.17
		Balsamorhiza sagittata	23.24 sq.cm.	Basal	1.13	2.70	2.39
		Comandra umbellata	0.09 sq.cm.	Diameter	0.004	0.060	15.00
"	Manti NF, Utah	*Bromus carinatus*	8 sq. cm.	Pantograph	3	5	1.67
		" "	1 sq. cm.		6	29	4.83
		" "	22 sq. cm.		13	21	1.62
Johnston, 1957	Alberta, Canada	*Stipa comata*	--	Point	2.31	4.40	1.90
		Bouteloua gracilis	--	Quadrat	33.83	64.30	1.90
		Festuca scabrella	--		3.87	8.40	2.17
		Agropyron smithii	--		5.32	14.65	2.75
		Koeleria cristata	--		0.79	2.20	2.78
		Carex spp.			3.65	18.35	5.03
		Total			48.28	81.74	1.69
Kinsinger, 1960	Northwest Nevada	*Artemisia tridentata*	--	Measured	4.1	4.9	1.20
		" "	--	Crown	20.9	27.3	1.31
		Atriplex confertifolia	--	and	10.8	16.0	1.48
		Eurotia lanata	--	Ellipse Formula	18.8	21.8	1.16

In tests made by Cook (1961) in Utah and Winkworth (1962) in Australia, plants had to occupy 50 percent or more of the loop before they were counted. This is a type of rated cover rather than frequency. These tests showed severe negative bias for small plants (e.g., grass bias of 0.41 by Cook), but had little apparent effect on large plants such as shrub crowns (e.g., *Artemisia tridentata* bias of 1.24 by Cook). Winkworth's work did provide an example of bias in litter hits of 1.15. Litter and other surface factors are recorded in the 3-step procedure only if they cover 1/2 or more of the loop--much like Cook and Winkworth did for plants.

The relation of loop-frequency, cover, and bias shown in Table 2 are similar to those reported by Parker and Harris (1959). Tests of crown cover of *Artemisia tridentata* and *A. cana* in California showed a very slight negative bias of 0.97, while for grassland types in Arizona high positive bias resulted--in one example it was 7.5.

Smith (1962) expressed the opinion that in plant populations where plant size remains fairly constant and the ratio of loop-frequency to cover (bias) also remains constant that changes in loop-frequency may serve as a reliable index of changes in cover.

Tests of loop-frequency sensitivity to naturally occurring changes in plant populations are rather scarce. Smith (1962) studied induced changes which did not permit the full display of population fluctuations likely to occur under natural conditions.

Parker and Harris (1959) report tests that indicate that loop-frequency is sensitive to obviously different condition classes. It is not clear if frequency would be sensitive to subtle naturally evolving changes within the different condition classes.

Additional study of loop-frequency sensitivity is needed involving natural changes occurring over time. Because loop-frequency forms the backbone of the 3-step procedure, it is the point presently most in need of study. However, other segments of the procedure including botanical composition, vigor measurements, and photographs will require study as well.

Certain progress has been made on interpretation of 3-step data (Parker and Harris, 1959; Hall, 1965). They point out many of the factors that should be considered and give some of the logical reasoning needed to interpret trend. Wood and Woolfolk (1960) state, "the magnitude of change required to indicate a real trend, upward or downward, must be one-quarter or more of the difference between the original measurement and the maximum potential."

Hall (1965) presents a "method of interpretation" in which one systematically and subjectively tests five assumptions about cause of trend. They are biotic causes, associated vegetation, erosion, climatic factors, and all factors together. In an interview with George Garrison in 1966, he expressed the view that the 3-step data, with an acceptable test for statistical significance, should be used as a "caution flag" or a warning.

Then within a framework of logic, the range manager should study more thoroughly the following four factors: (1) ecological stage, (2) watershed implications, (3) weather history and effects, and (4) use history (livestock, rodents, fire, etc.). Finally, in conjunction with interpretations from other clusters and/or other available information, a decision affecting the allotment may be reached.

Objectives and Scope

The third of the following four objectives is the main objective of the study. However it can be best satisfied only after much study of existing 3-step data (objective I) and certain applicable research data (objective II). Ideas for future improvement in the present method (objective IV) may evolve after satisfying the first three objectives.

I. Study and describe the magnitude of condition change indicated by conventional 3-step data from the Western Regions with special emphasis on major causes such as livestock grazing, weather cycles, natural plant dynamics, etc.

   A. What is the magnitude of measured change in range condition caused by all environmental factors involved without assignment of cause?

   B. What is the magnitude of measured change in range condition where livestock grazing is known to have two levels of influence--strong and none?

C. What is the estimated influence of other major causal agents upon the size of measured change in range condition?

These three questions will be answered first. Others may follow. Existing 3-step data from western forests will be used to answer these questions. Regular allotment clusters will be used for question A and C while clusters inside and outside of exclosures will be used to answer question B.

II. Study the effectiveness and sensitivity of the 3-step method in indicating change compared to indications from more exhaustive research measurements of factors like cover, density, production, utilization, etc., on the same area. Compile data showing how loop-frequency is related to cover or other factors and state how such relations may be used. Make assignment of cause from both 3-step data and more intensive research data and compare interpretations.

A. How do condition trends determined by the 3-step method compare to trends found by more intensive and comprehensive sampling of several factors from the same area?

B. Under what situations are the relationships between loop-frequency and other parameters, especially cover, such that changes in frequency can be used to reliably estimate changes in the other factors?

C. Is the interpretation of causal agent the same, using 3-step data exclusively, as it is when more comprehensive data from the same area are used?

To answer these questions we need data where the 3-step method and research methods have been used on the same site. Some existing research data may be used to meet this objective. If, however, the old data is incompatible with these objectives or otherwise deficient then new studies will be started on a coordinated basis with existing research projects.

III. Based on study of conventional 3-step data and intensive study on selected areas, prepare and help initiate use of guidelines for interpretation of existing 3-step data.

A. Based on answers to the above questions of objectives I and II and including other study results, what directions can be written and information furnished which will promote more effective use of 3-step data in interpretation of range condition trend?

B. Can the developed guidelines be successfully used on selected allotments in the six Western Regions?

IV. Discuss improvements needed in the basic 3-step procedure in light of limitations pointed out in these investigations and in the literature. Consider new techniques that would enhance the 3-step method and still be practical. These by-product suggestions go beyond interpretive guidelines and present methodology.

A. What additional information and improvement is suggested by this study and in pertinent literature which would strengthen the interpretive process in the future?

B. What newly developed techniques could be incorporated into the 3-step method to make future interpretation even more efficient?

Methods and Analyses

A. Using Data from the Western Regions

Existing 3-step transect data from western forests will be used to describe the magnitude of statistically significant change by major vegetation types, climatic zones, geomorphological provinces, or other broad geographical classifications (objective I). Assignment of cause will also be attempted.

Visits have been made with Regional Office and selected National Forest personnel in the six Western Regions to become aware of the nature of available 3-step data and that portion that may be effectively used to meet study objectives. A report of these visits was made in a memo to R. S. Driscoll dated January 4, 1967.

Suitable 3-step data with at least one remeasurement will be gathered with the aid of a questionnaire and key personnel

in the six Western Regions. The questionnaire will be sent out for a pretest in the six Regions during the 1967 field season. Ten examples of suitable cluster data will be collected from each Region. A critique of the questionnaire will be held in the fall of 1967 with key Regional Office personnel to prepare a final questionnaire. During the ensuing winter selected Forests from the six Western Regions will be completely screened for suitable data. Copies of selected 3-step data will be sent to Fort Collins where it will be compiled and analyzed by Rocky Mountain Station scientists. Additional Forests may be screened at a later date if needed.

The request for suitable 3-step data and accompanying questionnaire (copy in Appendix I) will be sent out by the Division of Range Management, Washington Office. It consists of five parts. Part A is a control section for name, location, and basic facts about each cluster. Part B contains quality screening questions for each cluster pertaining to date of measurement, plant identification, permanency of transects, site confounding, and effectiveness of exclosures. Part C provides for rejection of unsuitable data. Part D insures completeness of acceptable data and gives instructions for sending it to the Rocky Mountain Station. Part E will be used to draw out as much supplemental information as possible relative

to each acceptable cluster. It contains questions on site, livestock, big game and other use history, destructive influences, cultural improvement history, and estimated relative impact from different sources.

Statistical evaluation of selected 3-step data can be precisely described only after exploratory work with a sizable volume of data. Discussions with J. L. Kovner, R. M. Station biometrician, pointed this out. The limitations followed in laying out the 3-step transects will in turn limit the situations where appropriate statistical analyses can be made. A case in point is the 1-transect cluster, common in productive wet meadows. Such a cluster has only one sample and therefore variance cannot be computed. For the 2- and 3-transect clusters variance can be computed although the sample size is extremely small.

Initially, work will proceed with two kinds of data: (1) changes in loop-frequency measurements and (2) changes in vegetation and soil condition scores. This is with realization that the condition score is actually a combination of several loop frequency measurements that are then modified by a variable number and assortment of measurements and subjective observations.

For 2- and 3-transect clusters a 2-way analysis of variance (using transect and years as variables) will be tried

as an aid in the detection of statistically significant changes or trend. What, if anything, can be done statistically with the 1-transect cluster is not yet apparent.

Other tests like the mean and range test will be used where appropriate and useful. Study of the distribution of the data will help in the selection of appropriate tests. Degree of change standards advanced by Region 5 (Wood and Woolfolk, 1960) will be investigated to determine whether or not they are acceptable.

Three hypotheses follow which are relative to questions A, B, and C of objective I.

Hypothesis 1: The 3-step cluster data show enough units of change to indicate statistically significant up or down trends are occurring.

All acceptable 3-step data will be used to find out what proportions show statistically significant up, down, or static trends and to note the size of the recorded changes.

Hypothesis 2: Change measured inside exclosures (no grazing) compared to that outside (with grazing) shows enough difference to indicate significant up or down trends with grazing most likely a major cause outside with other causal agents responsible for change inside.

Data from exclosures will be used to describe magnitude of change where grazing influences are known to be either strong or nonexistant with measurements of both levels from the same site. The same degree of change due to climate can be assumed operative inside and out. Differences in degree of change between inside and out will likely be caused by the added livestock grazing effect unless supporting information indicates otherwise (e.g., differential rodent or insect use, etc.).

Hypothesis 3: Measured statistically significant change together with photographic evidence and available support data indicates up or down trends with the most likely cause(s) readily apparent.

All acceptable 3-step data plus photographs and the support section of the questionnaire will be brought together so that assignment of probable cause can be made, if possible, for each cluster. An estimate of the percentage of interpretable clusters will be made. Ideas of what is needed to make unexplainable data interpretable will be included.

Conclusions based on tests of these hypotheses follow the same general logic for all these questions:

1. If we fail to reject these hypotheses then two things appear likely:

a) Change is taking place and being measured.

b) Change due to heavy grazing, rest from grazing, or other known agents is being detected and major cause assigned.

2. If we reject the hypotheses, then one of two things appears likely:

a) Change is not taking place, or

b) Change, if it is taking place, is not being measured.

B. Intensive Study of Selected Areas

Study of 3-step transect data alone may not contribute enough for the development of interpretative guidelines especially when assignment of cause is a goal. Intensive study on a few selected areas should reveal just how well 3-step data detects or responds to known change induced by known causes (objective II). A check of existing research has uncovered a few cases where both the 3-step method and other methods have been used on the same areas where changes and causes are well established. One of these studies was carried out in New Mexico under project FS-RM-1604 and the data (unpublished) is on file and available in Albuquerque. The data from another study reported by Jameson (1962) is available to us for a follow-up measurement (in 1968) of 10-year change in an Arizona plant community that has never been grazed by livestock. Line intercept and 3-step

methods were among the procedures used to describe this plant community in 1958. A study at Black Mesa and another study at Manitou could furnish some additional past data for study.

Collaboration with Project FS-RM-1702 (Rated Microplot Study) will be made to obtain additional information about the relation between frequency and cover. Data collected from two sites at 17 locations on National Forest ranges and currently being analyzed are available. In addition, if the rated plot becomes a part of range allotment analysis it will be necessary to try to form a bridge between frequency (as with the 3/4-inch loop) and cover estimates. The microplot study will provide some of the knowledge necessary to develop such a crosswalk.

Most times, in the reservoir of past research, their objectives will not meet the objectives of this study. Therefore new studies are needed. On any new study areas careful measurements will be made by the 3-step method as well as other methods. Areas will be selected where desirable support data is, or can be, collected or on research areas where other measures of condition are being made on the same study plots. Where this study is in conjunction with approved studies of other research projects, analyses will usually be the same as planned for the other study.

New work was started and coordinated with other projects in 1966 on three areas; Manitou Experimental Forest in Colorado, Wild Bill Beef Study Area in Arizona, and Harvey Valley Allotment in California. On these areas more information will be obtained on the relation between frequency and cover. Also tests will be made of the sensitivity of 3/4-inch loop-frequency compared to plant community changes measured by more intensive research methods. Research methods used include plant cover by line intercept (Manitou) and point quadrat (Harvey Valley), density counts (Manitou), nearest plant composition (Harvey Valley), herbage yield and utilization (Wild Bill), and tree canopy measurements (Wild Bill and Harvey Valley).

Treatments in these studies are severe enough or of long enough duration that plant community changes should be substantial. At Manitou pretreatment measurements will be followed in May 1968 by application of different grazing treatments, fertilizer, and herbicides to study their effectiveness in promoting range recovery. A split plot design is used with 3 blocks and 20 subplots per block--resulting in 30,000 loop measurements. This study is in cooperation with Pat O. Currie (Project FS-RM-1701).

At Harvey Valley comparable pairs of study plots have been located in areas that have been under rest-rotation and

season-long management for over 10 years. Present differences in range condition can be attributed to grazing treatment. Our loop-frequency and nearest plant measurements taken in 1966 to coincide with those made during the recent Harvey Valley Evaluation will yield results as soon as analyzed. Remeasurement may be made in conjunction with a future evaluation. Differences in range condition between study plots is determined by tests of significance of differences between plot means. This work is in cooperation with Raymond D. Ratliff (Project FS-PSW-1701 (Rev.)).

At Wild Bill, a study is underway on effects of thinning dense ponderosa pine reproduction to various degrees upon herbage and beef production. Six degrees of thinning are represented from zero to 110 square feet basal area. Except for one clearcut that has been seeded, all vegetation changes are in native plant communities. In addition to loop-frequency measurements, permanent photographs have been taken along the 105 transects in the study area. This work is carried out in cooperation with Henry A. Pearson (Project FS-RM-1705) as well as personnel from the Division of Range and Wildlife Management, Region 3.

Study in cooperation with Dixie Smith (Project FS-RM-1703) will be started in 1967 in the alpine zone in northern Wyoming. Work will center on three new exclosures erected in 1966. Measurements of loop-frequency will be made both inside and

out of these exclosures on the same transects used to give estimates of ground cover.

At present no other plans exist for coordinating with other research projects, however, this possibility should not be overlooked. The idea that new studies will take too long before change occurs is not as valid as it sounds. More variation occurs from year to year than is often expected. In addition, studies like the one at Manitou will induce very rapid change because of the severe nature of the treatments. Another fruitful avenue would be by use of computer simulation of plant community changes. However, such simulation should follow study of real plant populations in order to adequately plan such involved work; therefore such a study is not planned for now.

Two hypotheses follow which apply to questions A, B, and C of objective II.

Hypothesis 1: Factors measured in the 3-step method are adequate and sensitive enough to plant community changes to make correct determinations of both trend and cause(s) of trend.

Tests of method sensitivity to known change will be made by comparing 3-step trend indications with indications of trend from more intensive research measurements. Tests of assignment of cause will be made by comparison after permitting specific support data (e.g., utilization, climate, etc.) to complement basic 3-step information.

Hypothesis 2: The relationships (bias) between loop-frequency and cover, while quite variable for different situations, are nevertheless useful and give a reasonable estimate of change in cover, provided certain parameters of plant size and distribution are well established.

If we fail to reject the above two hypotheses, then the 3-step method has value for detecting trend and, to a degree, assignment of cause. If the hypotheses are rejected then the method has shortcomings to such an extent that some procedural modification may be needed.

C. Producing Interpretive Guidelines

To answer the questions posed by objective III the information and experience gained from meeting objectives I and II will be assembled and guidelines written that can be used on typical 3-step transect clusters. Contents will include a systematic design for assembling pertinent data, then making appropriate analyses and logical interpretive use of the data. Parameters of condition change for a sizable mass of 3-step transect data may also be included along with examples of relations between loop-frequency versus cover and estimates of 3-step method sensitivity to change from various causes.

Finally, a few selected 3-step transect clusters will be picked in each Region for field trials of the interpretive

guidelines. These tests will likely lead to some adjustments in the guides as well as providing some training for National Forest personnel.

D. Suggested Changes in the Method

Objective IV covering any needed improvements or new techniques will be made only if they are practical and workable considering the present extensive deployment of the 3-step procedure. Such suggestions will be made only after fully explaining how to best use 3-step data as it is presently being collected.

Personnel Assignment

Jack N. Reppert is responsible for planning and conducting this study in close consultation with R. S. Driscoll, project leader. One permanent full-time technician will be required to most fully expedite this research within the 5-year time limit tentatively established by the Washington Office Division of Range Management, National Forest System, requestors and financial supporters of this study. During the field season, the assistance requirement may go as high as four helpers, technicians and aids included.

General Schedule

1. Discuss nature and availability of 3-step data with Western Regions, December 1965 to October 1966.

2. Request a large volume of selected data from Western Regions, July 1967 to April 1968.
3. Look for areas of past intensive research involving 3-step data, March 1966 to October 1966.
4. Decision to start new intensive studies. Soon after June 1966 to October 1967.
5. Submit final study plan, July 1967.
6. New intensive studies field work, summers of 1966, 1967, and 1968 at a minimum, through 1970 better. (Note: This new work would need to go beyond FY 1968.) Main Field Season dates: Harvey Valley 1966 and 1970; Manitou 1966, 1967, 1968, and 1970; Wild Bill every year 1965 through 1970; Carter Mountain 1967 and 1970.
7. Analyses of old 3-step data, October 1966 to October 1968.
8. Report of 3-step data parameters, December 1968.
9. Final report - 1969 to 1970.

Cooperation

This study is requested by the Washington Office, Division of Range Management, and is with their cooperation. Assistance from Western Regions and selected Forest staffs will be essential. In addition, cooperation will be required with certain research projects in the four Western Forest Service Experiment Stations.

LITERATURE

Cook, C. Wayne, and Thadis W. Box. 1961. A comparison of the loop and point methods of analyzing vegetation. J. Range Manage. 4(1): 22-27, illus.

Goodall, D. W. 1952. Some considerations in the use of point quadrats for the analysis of vegetation. Aust. J. Sci. Res. Ser. B 5(1): [1]-41, illus.

Greig-Smith, P. 1964. Quantitative plant ecology. 2nd ed. Butterworths, London. 256 p.

Hall, Fred. 1965. Interpretation of range trend. U. S. Forest Serv., Region 6, processed report, 17 p.

Hutchings, Selar S., and Ralph C. Holmgren. 1959. Interpretation of loop-frequency data as a means of plant cover. Ecology 40(4): 668-677, illus.

Hyder, D. N., R. E. Bement, E. E. Remmenga, and C. Terwilliger, Jr. 1965. Frequency sampling of blue grama range. J. Range Manage. 18(2): 90-94.

________. 1966. Vegetation-soils and vegetation-grazing relations from frequency data. J. Range Manage. 19(1): 11-17.

Hyder, D. N., C. E. Conrad, Paul T. Tueller, Lyle D. Calvin, C. E. Poulton, and Forrest A. Sneva. 1963. Frequency sampling in sagebrush-bunchgrass vegetation. Ecology 44(4): 740-746.

Jameson, Donald A., John A. Williams, and Eugene W. Wilton. 1962. Vegetation and soils of Fishtail Mesa, Arizona. Ecology 43(3): 403-410, illus.

Johnston, A. 1957. A comparison of the line interception, vertical point quadrat, and loop methods as used in measuring basal area of grassland vegetation. Can. J. Plant Sci. 37: 34-42.

Kinsinger, Floyd E., Richard E. Eckert, and Pat O. Currie. 1960. A comparison of the line-interception, variable-plot and loop methods as used to measure shrub-crown cover. J. Range Manage. 13(1): 17-21, illus.

Parker, Kenneth W. 1950. Report on 3-step method for measuring condition and trend of forest ranges. U. S. Forest Serv., Washington, D.C. 68 p., mimeo.

________. 1951. A method for measuring trend in range condition on national forest ranges. U. S. Forest Serv., Washington, D.C. 26 p., mimeo.

Parker, Kenneth W., and Robert W. Harris. 1959. The 3-step method for measuring condition and trend of forest ranges; a resume of its history, development and use. In Techniques and Methods of Measuring Understory Vegetation--A Symposium, Southern Forest Exp. Sta. and Southeastern Forest Exp. Sta., p. 55-69.

Pechanec, J. F. 1951. Progress report on Flagtail condition and trend methods study. U. S. Forest Serv., Pacific Northwest Forest and Range Exp. Sta., Portland, Oregon. 40 p., mimeo.

Sharp, L. A. 1954. Evaluation of the loop procedure of the 3-step method in the salt-desert shrub type of southern Idaho. J. Range Manage. 7: 83-88.

Smith, Justin G. 1962. An appraisal of the loop transect method for estimating root crown area changes. J. Range Manage. 15(2): 72-78.

Strickler, Gerald S. 1961. A grid method for obtaining loop readings on small plots. J. Range Manage. 14(5): 261-263.

Winkworth, R. E., R. A. Perry, and C. O. Rossetti. 1962. A comparison of methods of estimating plant cover in an arid grassland community. J. Range Manage. 15(4): 194-196, illus.

Wood, W. E., and E. J. Woolfolk. est. 1960. Developing a guide to interpret range trend from periodic measurements of three-step transects. U. S. Forest Serv., Region 5, typed. 18 p.

APPENDIX I

REQUEST AND QUESTIONNAIRE USED TO OBTAIN 3-STEP DATA OF HIGH QUALITY

PRE-TEST QUESTIONNAIRE

REQUEST FOR 3-STEP DATA

OF HIGH QUALITY

The purpose of the attached questionnaire is to acquire clear, permanent (non-fading) copies of original permanent 3-step data for analyses at the Rocky Mountain Forest and Range Experiment Station in Fort Collins. The product of these analyses will be guidelines for your future use in the interpretation of range condition trend. We intend to help you determine two things from examination of 3-step cluster data:

1) What, if any, trend in range condition has taken place?, and

2) What has, most likely caused the change?

Because the total volume of 3-step data is great, it is important that you carefully select data for this study so that data received is as near flawless as possible. By helping screen these data, two things will be accomplished:

1) Scientists in Fort Collins will not spend great amounts of time on data that, in the end, cannot be used, and

2) You, on the forests, will become more aware of segments of your data with flaws serious enough to make interpretation difficult or impossible. Part of the data with shortcomings will be correctable by you and part will be beyond salvage and therefore a candidate for abandonment.2/

To help in this sifting process, the attached 10 questions need to be asked about every cluster and answered accurately. If the questions can be answered with a "yes" the data will be suitable for our analyses and clear copies should be forwarded to us before September 15, 1967. All permanent 3-step transect data including initial establishment and all remeasurements should be screened--even those made as recently as the 1967 field season.3/ Permanent 3-step transects which are used to assess the impact of factors other than livestock (e.g., wildlife, recreation, etc.) are just as important in this study as those located primarily on livestock ranges.

2/ Note that "candidates for abandonment" should not be destroyed as a part of this data search. They should be set aside for a future final review by a designated authority before actually being destroyed. Terms of this final review should be decided by your Regional Office.

3/ All 3-step data will be screened in the winter 1967-68 sampling. For the pre-test, screen only enough data to obtain 10 sets that pass the test of the questionnaire.

Questionnaire for
THREE-STEP DATA QUALITY SCREENING
AND SUPPORT DATA GATHERING

for

Study of Range Condition Trend Interpretation

PART A - CONTROL INFORMATION FOR EACH CLUSTER
(Complete for all established clusters[4/])

Region ________ Forest (or Grassland) ____________ Ranger Dist. ____________ State ____________
(number) (name) (name)

County ____________ Township ____________ Range ____________ Section ____________

Allotment ____________ Cluster ____________ Transect numbers ____________
(name) (name and number)

Cluster (check one): (1) Inside livestock or game exclosure ____________

(2) Outside and paired with cluster inside livestock or game exclosure ____________

(3) On range subject to grazing and not paired with an exclosure cluster ____________

List all dates (chronologically) of cluster measurements including month, day, and year, (e.g., 8/27/65). No. 1 is establishment date.

1. ________ 2. ________ 3. ________ 4. ________ 5. ________ 6. ________

7. ________ 8. ________ 9. ________ 10. ________ 11. ________ 12. ________

13. ________ 14. ________ 15. ________

Remarks (if needed to clarify above facts):

PART B - QUALITY SCREENING FOR EACH CLUSTER
(Fill out for all established clusters[4/]
completing first five questions and
sixth if it applies.)

1. Are two or more cluster measurements within a month-day time span of 30 days? (check one)

Yes ________ No ________

2. Are two or more measurements made within a time span when plant phenology is optimum (or nearly so) for identification of key plants? (check one)

Yes ________ No ________

3. Do you think the important species are properly identified? (check one)

Yes ________ No ________

4. Have the original transects within this cluster been used at each measurement date (located as permanently as possible within the 100- by 150-foot macro plot)?

Yes ________ No ________

(If No, why aren't they ? ____________________________________)

4/ For the pre-test screen only enough data to obtain 10 sets that pass the test of the questionnaire.

5. Has the cluster been located on one range site so that there are no obvious site differences within or between transects?

Yes ____________ No ____________

6. <u>Answer only if the cluster is inside an exclosure</u>: Have large animals (Livestock or game), intended for exclusion, been kept out of the exclosure, thus never seriously grazing or disturbing the area?

Yes ____________ No ____________

Remarks: If needed to clarify 1 to 6 above:

PART C - REJECTION OF UNSUITABLE CLUSTER DATA
(Fill out for <u>all</u> <u>established</u> <u>clusters</u>[5])

If any one of the first five "yes" or "no" questions (six for exclosure clusters) in Part B were answered <u>No</u>, then the data is unsuitable for this study.

If the first five or six (for exclosure clusters) answers are <u>Yes</u>, then the data is <u>tentatively acceptable</u> and you should proceed with answers to further questions in Parts D and E. First answer question 7

7. Based on the evaluation through Part B, are data from this cluster fit for analyses and interpretation?

Yes __________ No __________

IF YES, CONTINUE ON TO PART D.

IF NO, STOP HERE AND SEND IN QUESTIONNAIRE COMPLETE THROUGH PART C, QUESTION 7.

PART D - CHECK TENTATIVELY ACCEPTABLE CLUSTER DATA
FOR COMPLETENESS AND FINAL ACCEPTANCE
(Complete all questions)

8. Are all segments of the data complete, procedurally correct, and legible for all measurement dates?

(Segments include transect and cluster summary sheets, photographs, and trend records)

Yes __________ No __________

9. Are data, for all measurement dates, evaluated using the same acceptable condition scorecard and summarized using the same acceptable rules of desirability (e.g., forage density index) or combination (e.g., ground cover index)?

Yes __________ No __________

10. If either or both question 8 or 9 is answered <u>No</u>, then answer this question: <u>Can the deficiency be corrected</u> so that the data are complete and usable for <u>at least two or more measurement dates</u>?

Yes __________ No __________

IF QUESTIONS 8 AND 9 ARE ANSWERED <u>YES</u> ALL DATA FROM THIS CLUSTER IS FULLY AND FINALLY ACCEPTABLE. CONTINUE WITH PART E OF THE QUESTIONNAIRE

IF QUESTION 10 IS ANSWERED <u>YES</u> THEN DATA FROM AT LEAST TWO MEASUREMENT DATES ARE ACCEPTABLE AS SOON AS YOU MAKE THE REQUIRED CORRECTIONS. MAKE THOSE CORRECTIONS AND DO PART E OF THE QUESTIONNAIRE.

IF QUESTION 10 IS ANSWERED <u>NO</u>, THEN DATA IS NOT ACCEPTABLE FOR FURTHER ANALYSES, BUT RETURN QUESTIONNAIRE COMPLETE THROUGH PART D.

Remarks (if needed to clarify 8 to 10 above):

____

____

____

---

[5] For the pre-test screen only enough data to obtain 10 sets that pass the test of the questionnaire

If questions 8 and 9 or question 10 are answered Yes, the data (or at least data from two measurement dates) are acceptable and three things are now required:

(1). Make permanent (non-fading) copies of all segments of acceptable data (transect, cluster, and trend sheets) and prints of photographs. Do not make copies of data by hand. Do not type new sheets. Use xerox or similar permanent copying procedures.

(2) Fill out the Supplemental Information Form (PartE) as completely as possible, and

(3) Carefully package and mail the copied data and photo prints, Questionnaire, and the Supplemental Data Form to:

Range Trend Study
c/o Jack N. Reppert
Rocky Mountain Forest and Range Experiment Station
240 West Prospect
Fort Collins, Colorado 80521

PART E - SUPPLEMENTAL INFORMATION
FOR EACH ACCEPTABLE CLUSTER
(Be as complete as possible and still be accurate;
if answer not possible write "N".)

1. Site Description for 100- by 150-foot macro plot.

a. Land forms (check one):

Drainage bottom ________ Slope ________ Ephemeral pond ________ Butte ________

Flood plain ________ Plateau ________ Alluvial fan ________

Ridge top ________ Plain ________ Other ________

b. Steepness and direction of slope: Percent slope ________ Aspect (if over 1% slope)________

c. Parent material (check one):

Residual ________ Aeolian ________ Stream Alluvial ________ Glacial ________

Lake Alluvial ________ Organic ________ Marine Alluvial ________ Colluvial ________

Do Not Know ________

d. Underlying rock type (name specific rock after the general rock type and add descriptive word if needed; e.g., decomposed granite).

Igneous rocks ________ Metamorphic rocks ________

Sedimentary and precipitate rocks ________

Unconsolidated (Pumice, Sand, Loess, Till) ________ Do Not Know ________

e. Effective soil depth (judged by herbaceous or shrub rooting depth--Check one):

Less than 1 foot ________ 1 to 2 feet ________ 2 to 3 feet ________

Over 3 feet ________

f. Texture of soil horizons (check two):

Texture	A or surface horizon	B or subsurface horizon
Sand	________	________
Sandy loam	________	________
Loam	________	________
Clay loam	________	________
Clay	________	________

g. pH of surface and subsurface horizons

Surface ________ Subsurface________

h. Class of surface coverage of rocks from gravel to boulders (check one):

Less than 2% ________ 2.1 - 5% ________ 5.1 - 10% ________ 10.1 - 25% ________

25.1 - 50% ________ 50.1 - 90% ________

i. Soil horizon rockiness (estimate of percent of volume):

	A or surface horizon	B or subsurface horizon		A or surface horizon	B or subsurface horizon
Gravelly			Stoney		
Cobbly			Boulders		

j. Other descriptive remarks about the soil (e.g., claypan at 12 inches, poorly drained, soil erosion, etc.):

k. Climate--Give precipitation total, seasonal distribution, and percent as snow and rain. Also mean annual temperature, average maximum and minimum for July and January.

l. Plant community name (Dominant plant species in each layer--e.g., Pipo/Putr-Artr/Feid-Stoc):

____

m. Estimated tree crown closure over 100- by 150-foot plot (name species):

________ ________ ________ ________ ________

n. Ecological stage--Briefly describe the present ecological situation with reference to the climax plant community:

o. Site potential as reflected by present plant community responses:

Average and range in herbage yield (lbs. air-dry)	(average)	(high)	(low)
Average and range in date of range readiness	(average)	(early)	(late)

p. Nearby areas of comparable site.

How many acres do you estimate there are on this allotment where the site potential, plant community, and grazing treatment are comparable to the area where these 3-step plots are located, so that results are directly applicable to the larger area? ________________

2. Livestock Use History on the 100- by 150-foot macro plot(s) and nearby areas of comparable site. Include mention of (kind) and class of livestock, and dates when area subject to possible grazing; also include system of grazing and trends in stocking rate and degree of herbage utilization.

a. Detailed comments since 1950.

b. General comments for period before 1950.

3. Big Game Use History on 100- by 150-foot macro plot(s) and nearby areas of comparable site: Include type of game, season of use, utilization, conflicts with domestic stock, etc.

   a. Detailed comments since 1950.

   b. General comments for period before 1950.

4. Other Values and Uses for macro plot(s) and nearby areas of comparable site Briefly describe; consider other values such as timber, small game, recreation, watershed, scenery, natural history, etc.

5. Destructive influences affecting the 100- by 150-foot macro plot(s). Give brief history of outbreaks of factors like fire, insects, disease, rodents, flood, etc. Describe the factor, date of occurrence, severity, and effects on plants growing on the macro plot(s) and nearby comparable site.

6. Give history of cultural improvements. Include details such as date, treatment, success, and present condition of improvement.

   a. Seeding:

   b. Plant Control (e.g., herbicide, controlled burn, etc.):

   c. Fertilization:

   d. Etc.:

7. Estimated relative impact (or influence) upon the plant community within the cluster (transects and macro plots) from different impact sources for each 3-step measurement period. These impact sources refer to happenings throughout the allotment as well as those that may have occurred on or in the immediate vicinity of the macro plot. Use subjective rating of heavy (H), moderate (M), light (L), and absent (A) as an estimated relative impact. Period 1 is from establishment date to second measurement date.

Measurement Period

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	1)Drought															
Climatic Conditions	2)Abundant Moisture															
	3)Normal															
	4)Etc.1/															
	Cattle															
	Sheep															
Grazing and Browsing	Horses															
	Deer															
	Elk															
	Etc.1/															
	Ground Squirrel															
Small Animal Use	Mice															
	Gophers															
	Etc.1/															
	Seeding															
	Fertilizing															
Manage-ment	Spraying															
	Burning															
	Water Development															
	Etc.1/															
	Recreation															
	Watershed Manipulation															
Other Interests	Timber Harvest															
	Timber Stand Improvement															
	Etc.1/															

1/ Under the Etc. category in all cases, indicate additional items you believe may have influenced the vegetation.

Measurement Period

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Wildfire															
	Insects															
Destructive Outbreaks	Disease															
	Etc.1/															

1/ Under the Etc. category in all cases, indicate additional items you believe may have influenced the vegetation.